

本科全英语课程采用如下英文版教学大纲

## Syllabus Sample of Fudan University

**Department: Environmental Science and Engineering**

**Date: 30 August 2024**

<b>Course Code</b>	ENVI30044						
<b>Course Title</b>	Global Environmental Change						
<b>Credit</b>	2	<b>Experiment (including Computer) Credit</b>	0	<b>Practice Credit</b>	0	<b>Aesthetic Education Credit</b>	0
<b>Credit Hours Per Week</b>	2	<b>Education on The Hard-Working Spirit Credit Hours</b>	0	<b>Language of Instruction</b>	Engl ish	<b>Honors Course</b>	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
<b>Course Type</b>	<input type="checkbox"/> Core General Education Course <input type="checkbox"/> Specific General Education Course <input type="checkbox"/> Basic Course in General Discipline <input checked="" type="checkbox"/> Others			2+X Major : <input type="checkbox"/> Professional Core Course <input checked="" type="checkbox"/> Professional Advanced Course			
				Non 2+X Major : <input type="checkbox"/> Professional Compulsory Course <input type="checkbox"/> Professional Elective Course			
<b>Course Objectives</b>	(Including value, knowledge and ability objectives) <b>Knowledge objectives:</b> 1) Tell the basic concepts and terminology involved in global environmental change. 2) Describe various changes in the Earth's environment and their relationship with 'global warming'. 3) Explain the scientific principles and main driving factors for various changes of global environment. <b>Ability objectives:</b> 4) Apply the theories and models learned to analyze environmental changes and impacts in different countries and regions. 5) Link environmental changes with the economic development or population health of a certain region. 6) Obtain information from relevant literature and write a logical review on a specific issue of global environmental change. <b>Value objectives:</b> 7) Identify your strengths, collaborate effectively with others, and actively participate in group discussions and reports. 8) Understand the concept of a "community of human and natural life" and attach importance to natural environmental protection.						

	9) Concern about global environmental issues and support the use of clean energy and low-carbon living.
<b>Course Description</b>	This course mainly teaches various changes that are happening or will be faced by the Earth's environment related to human survival and life, including extreme weather events, changes in precipitation pattern, sea level rise, changes in carbon cycle process, ecosystem evolution, ocean acidification, Arctic pollution, etc. It will compare the modern changes with paleo-environments, explain their scientific principles (such as basic greenhouse model), driving factors (such as IPAT decomposition of carbon emissions), measurement methods (such as radiative forcing), interrelationships (such as global warming and sea level rise), regulatory mechanisms (such as sand dust deposition and marine carbon cycle), and development trends (such as cryosphere reduction), identify the impacts of human activities (such as global climate sensitivity estimates), and explore how to adapt and mitigate (such as limiting global temperature rise to 1.5°C).
<b>Course Requirements:</b> No specific requirements. You can be any academic background.	
<b>Teaching Methods:</b> Knowledge units are taught in combination with student self-assessment. Exercises are mainly conducted through after-school assignments. Case analysis questions are analyzed and displayed through classroom Think-Pair-Share. Team projects, discussion, and presentation are conducted through group study.	
<b>Course Director's Academic Background:</b> Prof. Chen obtained her Ph.D. from the University of Maryland at College Park. Her research focuses on atmospheric aerosols and biogeochemistry. Her working group has continued the aerosol observation at Huaniao island for over a decade, and had revealed source contributions, metal solubility, deposition fluxes, biogeochemical effects and linkage with the surface phytoplankton biomass. She has published more than 60 papers with over 4,500 citations. She has become a member of China Surface Ocean-Lower Atmosphere Study (SOLAS) committee since 2014 and an associate editor for Environmental Chemistry since 2020.	
<b>Instructor's Academic Background:</b> Prof. Wang obtained his Ph.D. from Peking University. His research focuses on anthropogenic and natural aerosols, atmospheric chemistry, climate change, Earth science and carbon economics. Specifically, his group is concentrated on studying the chemical and physical mechanisms in aerosol formation, and its health and climate impacts. They also explore the interaction between the human energy system and climate change. Prof. Wang has published	

more than 70 papers up to now, including Nature.

#### Members of Teaching Team

Name	Gender	Professional Title	Department	Responsibility
Chen, Ying	Female	Professor	Environ. Sci. & Engr.	Teaching in weeks 1-8
Wang, Rong	Male	Professor	Environ. Sci. & Engr.	Teaching in weeks 9-15

#### Course Schedule (Please supply the details about each lesson):

##### Week 1: Introduction

- 1.1 Course introduction
- 1.2 IPCC and assessment report
- 1.3 Global change content and nature
- 1.4 Climate change problems and risks
- 1.5 Climates from 1.5°C warming
- 1.6 Film "Six Degrees Could Change the World"

##### Week 2: Model the Earth's temperature

- 2.1 Blackbody planet
- 2.2 Stefan-Boltzmann law
- 2.3 Solar constant
- 2.4 Surface temperature calculation
- 2.5 n-layer model
- 2.6 Earth's energy budget

##### Week 3: Radiative forcing and greenhouse gases

- 3.1 Radiative forcing concept and calculation
- 3.2 Global average RF of various gases
- 3.3 Country's contribution and cumulative emission
- 3.4 Albedo change
- 3.5 Greenhouse gases: sources and trends

##### Week 4: Modern climate and trends

- 4.1 Atmospheric circulation and ocean currents
- 4.2 Trends in temperature and precipitation
- 4.3 Milankovitch theory
- 4.4 Paleoclimate: Zachos curve and CENOGRIID
- 4.5 Global warming and human impact
- 4.6 Diurnal temperature range and heat island effect
- 4.7 Change of precipitation

##### Week 5: Cryosphere and sea level change

- 5.1 Cryosphere concept
- 5.2 Role of cryosphere in climate system
- 5.3 Northern and southern poles
- 5.4 Historical change of Sea level
- 5.5 Social influence of sea level rise
- 5.6 Sea level measurements

- 5.7 Causes and prediction of sea level
- Week 6: Lessons from paleo: temperature and abrupt changes
  - 6.1 Temperature reconstruction
  - 6.2 Warming in 20<sup>th</sup> century
  - 6.3 Abrupt cooling and thermohaline circulation
  - 6.4 El Nino-Southern Oscillation (ENSO)
  - 6.5 Drought and other abrupt changes
  - 6.6 Extreme weather this year
- Week 7: Drivers: population and energy
  - 7.1 History and status of population growth
  - 7.2 Growth impacts on environment and resources
  - 7.4 Energy concept and categories
  - 7.5 Status of energy consumption
  - 7.6 Environmental impact of energy consumption
  - 7.7 The IPAT identity
  - 7.8 Stabilization wedges and carbon neutralization
- Week 8: Ocean acidification and species extinction
  - 8.1 Ocean acidification concept and cause
  - 8.2 Impacts on species and ecosystem
  - 8.3 Monitoring and coping strategies
  - 8.4 Species extinction concept and causes
  - 8.5 Impacts on ecosystem and human society
  - 8.6 Biodiversity protection and international convention
- Week 9: Persistent organic pollutants in the Arctic
  - 9.1 Introduction to POPs
  - 9.2 POPs in multi-compartments
  - 9.3 Ecological risk of PCBs in ringed seal
  - 9.4 Polycyclic aromatic hydrocarbons
  - 9.5 Global transport routes of POPs
    - 9.5.1 Oceanic routes
    - 9.5.2 Three stages of POPs in the air
    - 9.5.3 Global atmospheric circulations
    - 9.5.4 Global distillation
- Week 10: Modeling the atmospheric transport of POPs to the Arctic
  - 10.1 Story 1: Halsall et al., AE, 2001
  - 10.2 Story 2: Wang et al., EST, 2009
  - 10.3 Story 3: Zhang et al., ACP, 2012
- Week 11: Black carbon modeling (1)
  - 11.1 Why Black Carbon
  - 11.2 Definition of black carbon
  - 11.3 Morphology
  - 11.4 Optical method: equivalent BC
  - 11.5 Thermal method: elemental carbon
  - 11.6 Modeling BC emissions
    - 11.6.1 The first BC emission inventory
    - 11.6.2 BC inventory 2: Penner et al., 1993
    - 11.6.3 BC inventory 3: Cooke and Wilson, 1996
    - 11.6.4 BC inventory 4: Cooke et al., 1999

- 11.6.5 BC inventory 5: Bond et al., 2004
- Week 12: Black carbon modeling (2)
  - 12.1 Modeling BC transport
    - 12.1.1 General Circulation Model
    - 12.1.2 12.1.2 Atmospheric processes of BC
  - 12.2 Modeling the radiative forcing of BC
    - 12.2.1 Model 1: Cooke et al., 1999
    - 12.2.2 Model 2: Jacobson, 2001
    - 12.2.3 Models 3: AeroCom: a model inter-comparison study
    - 12.2.4 Model 4: Ramanathan & Carmichael, 2009
    - 12.2.5 Model 5: Bond et al., 2013
    - 12.2.6 12.2.6 Model 6: Wang et al., 2016
- Week 13: Aerosol fertilizing Earth biomass
  - 13.1 Why atmospheric nutrients?
  - 13.2 The Cycle of Nitrogen
    - 13.2.1 N compounds in the Earth system
    - 13.2.2 N pools in the Earth system
    - 13.2.3 Preindustrial N cycle
    - 13.2.4 Modern N cycle
    - 13.2.5 Human perturbances to the N cycle
  - 13.3 The Cycle of Iron
    - 13.3.1 Fe content in the Earth
    - 13.3.2 Global Fe cycle and the climate
    - 13.3.3 Sources of Fe in the oceans
    - 13.3.4 Fe and ocean biogeochemistry
    - 13.3.5 The Iron hypothesis
    - 13.3.6 Mesoscale iron-fertilization experiments
  - 13.4 The Cycle of Phosphorus
    - 13.4.1 P cycle in land ecosystems
    - 13.4.2 Global P cycle
    - 13.4.3 Retention of P
    - 13.4.4 Chemical weathering of P
    - 13.4.5 P cycle in the atmosphere
    - 13.4.6 Imbalance of N and P
    - 13.4.7 Marine P limitation
- Week 14: Modeling the biogeochemical effects of aerosol
  - 14.1 Model 1: Hudson et al., 1994
  - 14.2 Model 2: Townsend et al., 1996
  - 14.3 Model 3: Nadelhoffer et al., 1999
  - 14.4 Model 4: Zaehle et al., 2011ab
  - 14.5 Model 5: Zaehle et al., 2011
  - 14.6 Model 6: Krishnamurthy et al., 2009,2010,2011
  - 14.7 Model 7: Wang et al., 2015abc,2017
- Week 15: Solutions for the climate change
  - 15.1 Challenges of climate change
  - 15.2 Decarbonization of the energy system
  - 15.3 Technology innovation
  - 15.4 Technology options

- 15.5 Climate mitigation
- 15.6 William Nordhaus and DICE
  - 15.6.1 Welfare dynamics
  - 15.6.2 Climate damage
  - 15.6.3 Carbon tax and carbon price
  - 15.6.4 Model structure

Week 16: In-class presentation

Week 17-18: Term paper

**The design of class discussion or exercise, practice, experience and so on:**

This course features self-assessment (knowledge points), Think-Pair-Share (questions), peer review (assignments and classroom presentation), and group discussion (as follows).

Chapter 1: Each group selects one aspect (ecosystem, society, and public health, etc.) to discuss the impact of climate change.

Chapter 3: Group discussion on “The principle of common but differentiated responsibilities among countries”.

Chapter 4: Group discussion on the interactions between warming and atmosphere and ocean.

Chapter 5: Each group selects different islands or low-lying countries and regions to analyze the impacts of sea level rise.

Chapter 6: Each group selects the extreme weather and climate events that occurred in different regions of the world this year and analyzes the causes and adverse effects.

Chapter 7: Each group selects different types of clean energy and analyzes advantages and disadvantages, current development, and prediction.

Group members may use structured discussion mode to summarize and report in class.

**If you need a TA, please indicate the assignment of assistant:**

TA will help with grading the assignments, arranging the group discussion, in-class presentation, and answering questions.

**Grading & Evaluation** (Provide a final grade that reflects the formative evaluation process):

Class performance (including attendance, assignment completion, participation in group study, etc.): 50%

Final in-class presentation: 10%

Term paper: 40%

<b>Usage of Textbook:</b> <input type="checkbox"/> Yes(complete textbook information form below) <input checked="" type="checkbox"/> No						
<b>Textbook Information</b> (No more than two textbooks) :						
Title	Author	ISBN	Publishing Time	Publisher	Type I	Type II
					<input type="checkbox"/> Self-compiled Textbook (Published) <input type="checkbox"/> Non-mainland Textbook <input type="checkbox"/> Other Textbook (Published)	<input type="checkbox"/> National Planning Textbook <input type="checkbox"/> Provincial and Ministerial Planning Textbook <input type="checkbox"/> School Level Planning Textbook <input type="checkbox"/> Others
					<input type="checkbox"/> Self-compiled Textbook (Published) <input type="checkbox"/> Non-mainland Textbook <input type="checkbox"/> Other Textbook (Published)	<input type="checkbox"/> National Planning Textbook <input type="checkbox"/> Provincial and Ministerial Planning Textbook <input type="checkbox"/> School Level Planning Textbook <input type="checkbox"/> Others
<b>Teaching References</b> (Including author, title, publisher, publishing time,ISBN):  Introduction to Modern Climate Change, 2 <sup>nd</sup> Edition, Andrew Dessler, Cambridge University Press, published online 2019  Intergovernmental Panel on Climate Change the Sixth Assessment Report 2023						

Table column size can be adjusted according to the content.